MULTIMEDIA UNIVERSITY

STUDENT ID NO

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# MULTIMEDIA UNIVERSITY

# FINAL EXAMINATION

**TRIMESTER 1, 2019/2020**

## ETN4086 – MOBILE AND SATELLITE COMMUNICATIONS

(TE)

17 OCTOBER 2019
2.30 p.m. – 4.30 p.m.
(2 Hours)

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**INSTRUCTION TO STUDENT**

1. This examination paper consists of **10 pages** (including the cover page) with **4 questions only**.

2. Each question is worth **25 marks. Attempt ALL questions.**

3. Please write all your answers in the Answer Booklet provided. **Show all relevant steps** to obtain maximum marks.

4. There is an **appendix** of useful charts, constants and formulae at the end of this question paper.

(vi) Discuss the impact of changing the GOS from (c) (iv) to 0.1% to the users.
[2 marks]

**Question 2**

(a) Company A has conducted a test drive for the new Fifth Generation (5G) system in Putrajaya and Cyberjaya area to find the propagation of a signal between a transmitter and a receiver using the TV Whitespace frequency of 700MHz. The effective base station height, $h_{te,}$ is 35m and the effective mobile antenna height, $h_{re,}$ is 1.5m. The transmitter power, $P_t$, is given as 69.44W. The field measurement revealed that path loss at 10km was measured to be approximately 150dB.

(i) Estimate the path loss using the Free Space Loss (FSL) model if the received power, $P_r$, at 10km is $10\text{x}10^{-11}$W.
[2 marks]

(ii) Using the Hata model, estimate the median path loss, $L_{50}$, at 10km.
[4 marks]

(iii) Discuss the difference in the path loss estimated values between the FSL model and the Hata model.
[3 marks]

(iv) State one constraint of the Hata model.
[1 mark]

***Hint:*** *Hata model*

$$L_{50} = 69.55 + 26.16\log f_c - 13.82\log h_{te} - a(h_{re}) + (44.9 - 6.55\log h_{te})\log d$$

*Antenna correction factor for large city is given as:*

$a(h_{re}) = 8.29(\log (1.54\, h_{re}))^2 - 1.1$ dB, $f_c \leq 300$MHz

$a(h_{re}) = 3.2(\log (11.75\, h_{re}))^2 - 4.97$ dB, $f_c > 300$MHz

(b) Describe the difference between flat fading and frequency selective fading.
[6 marks]

(c) Discuss THREE features in the new Fifth Generation (5G) mobile networks that makes it more superior as compared to the current Fourth Generation (4G) networks.
[9 marks]

**Continued...**

## Question 4

(a) Discuss the components in the communication subsystem of a satellite.

[ 6 marks]

(b)

Table Q4.1

| | |
|---|---|
| Transmitting power at satellite antenna, $P_T$ | 50 W |
| Satellite antenna 3 dB beamwidth, $\theta_{3dB}$ | 2.5° |
| Downlink losses | |
| Polarization loss | 2.5 dB |
| Rainfall loss | 2.0 dB |
| Antenna misalignment loss | 1.0 dB |
| Atmospheric absorption loss | 0.6 dB |
| Off contour loss | 0.5 dB |
| Assume no branching and feeder loss | |
| Antenna efficiency, $\eta$ | |
| Earth station antenna | 0.75 |
| Satellite antenna | 0.70 |
| Typical radius of geostationary satellite orbit | 42,157 km |

An earth station in Cyberjaya, Malaysia, utilizes an 8m parabolic reflector to receive a signal from a geostationary satellite, AsiaSat 9 , at 122.1°E. The uplink frequency, $f_U$, and downlink frequency, $f_D$, are in the 14GHz and 12GHz bands, respectively. Given the parameters in Table Q4.1 above, perform a link budget analsyis by calculating the following parameters:

(i) Gain of the satellite station's transmitting antenna (dBi).

[3 marks]

(ii) Gain of the earth station's receiving antenna (dBi).

[3 marks]

(iii) Effective Isotropic Radiated Power (EIRP) (dBW) of the transmitted signal.

[3 marks]

(iv) Power flux density at the earth station.

[3 marks]

(v) Total losses (dB) from the satellite to earth station receiving antenna.

[5 marks]

(vi) Power received (dBW) by the earth station's receiver.

[2 marks]

**Continued...**

## Appendix III: Erlang B and Erlang C Chart

### Erlang B Traffic Table

Maximum Offered Load Versus B and N
B is in %

| N/B | 0.01 | 0.05 | 0.1 | 0.5 | 1.0 | 2 | 5 | 10 | 15 | 20 | 30 | 40 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | .0001 | .0005 | .0010 | .0050 | .0101 | .0204 | .0526 | .1111 | .1765 | .2500 | .4286 | .6667 |
| 2 | .0142 | .0321 | .0458 | .1054 | .1526 | .2235 | .3813 | .5954 | .7962 | 1.000 | 1.449 | 2.000 |
| 3 | .0868 | .1517 | .1938 | .3490 | .4555 | .6022 | .8994 | 1.271 | 1.603 | 1.930 | 2.633 | 3.480 |
| 4 | .2347 | .3624 | .4393 | .7012 | .8694 | 1.092 | 1.525 | 2.045 | 2.501 | 2.945 | 3.891 | 5.021 |
| 5 | .4520 | .6486 | .7621 | 1.132 | 1.361 | 1.657 | 2.219 | 2.881 | 3.454 | 4.010 | 5.189 | 6.596 |
| 6 | .7282 | .9957 | 1.146 | 1.622 | 1.909 | 2.276 | 2.960 | 3.758 | 4.445 | 5.109 | 6.514 | 8.191 |
| 7 | 1.054 | 1.392 | 1.579 | 2.158 | 2.501 | 2.935 | 3.738 | 4.666 | 5.461 | 6.230 | 7.856 | 9.800 |
| 8 | 1.422 | 1.830 | 2.051 | 2.730 | 3.128 | 3.627 | 4.543 | 5.597 | 6.498 | 7.369 | 9.213 | 11.42 |
| 9 | 1.826 | 2.302 | 2.558 | 3.333 | 3.783 | 4.345 | 5.370 | 6.546 | 7.551 | 8.522 | 10.58 | 13.05 |
| 10 | 2.260 | 2.803 | 3.092 | 3.961 | 4.461 | 5.084 | 6.216 | 7.511 | 8.616 | 9.685 | 11.95 | 14.68 |
| 11 | 2.722 | 3.329 | 3.651 | 4.610 | 5.160 | 5.842 | 7.076 | 8.487 | 9.691 | 10.86 | 13.33 | 16.31 |
| 12 | 3.207 | 3.878 | 4.231 | 5.279 | 5.876 | 6.615 | 7.950 | 9.474 | 10.78 | 12.04 | 14.72 | 17.95 |
| 13 | 3.713 | 4.447 | 4.831 | 5.964 | 6.607 | 7.402 | 8.835 | 10.47 | 11.87 | 13.22 | 16.11 | 19.60 |
| 14 | 4.239 | 5.032 | 5.446 | 6.663 | 7.352 | 8.200 | 9.730 | 11.47 | 12.97 | 14.41 | 17.50 | 21.24 |
| 15 | 4.781 | 5.634 | 6.077 | 7.376 | 8.108 | 9.010 | 10.63 | 12.48 | 14.07 | 15.61 | 18.90 | 22.89 |
| 16 | 5.339 | 6.250 | 6.722 | 8.100 | 8.875 | 9.828 | 11.54 | 13.50 | 15.18 | 16.81 | 20.30 | 24.54 |
| 17 | 5.911 | 6.878 | 7.378 | 8.834 | 9.652 | 10.66 | 12.46 | 14.52 | 16.29 | 18.01 | 21.70 | 26.19 |
| 18 | 6.496 | 7.519 | 8.046 | 9.578 | 10.44 | 11.49 | 13.39 | 15.55 | 17.41 | 19.22 | 23.10 | 27.84 |
| 19 | 7.093 | 8.170 | 8.724 | 10.33 | 11.23 | 12.33 | 14.32 | 16.58 | 18.53 | 20.42 | 24.51 | 29.50 |
| 20 | 7.701 | 8.831 | 9.412 | 11.09 | 12.03 | 13.18 | 15.25 | 17.61 | 19.65 | 21.64 | 25.92 | 31.15 |
| 21 | 8.319 | 9.501 | 10.11 | 11.86 | 12.84 | 14.04 | 16.19 | 18.65 | 20.77 | 22.85 | 27.33 | 32.81 |
| 22 | 8.946 | 10.18 | 10.81 | 12.64 | 13.65 | 14.90 | 17.13 | 19.69 | 21.90 | 24.06 | 28.74 | 34.46 |
| 23 | 9.583 | 10.87 | 11.52 | 13.42 | 14.47 | 15.76 | 18.08 | 20.74 | 23.03 | 25.28 | 30.15 | 36.12 |
| 24 | 10.23 | 11.56 | 12.24 | 14.20 | 15.30 | 16.63 | 19.03 | 21.78 | 24.16 | 26.50 | 31.56 | 37.78 |
| 25 | 10.88 | 12.26 | 12.97 | 15.00 | 16.13 | 17.51 | 19.99 | 22.83 | 25.30 | 27.72 | 32.97 | 39.44 |
| 26 | 11.54 | 12.97 | 13.70 | 15.80 | 16.96 | 18.38 | 20.94 | 23.89 | 26.43 | 28.94 | 34.39 | 41.10 |
| 27 | 12.21 | 13.69 | 14.44 | 16.60 | 17.80 | 19.27 | 21.90 | 24.94 | 27.57 | 30.16 | 35.80 | 42.76 |
| 28 | 12.88 | 14.41 | 15.18 | 17.41 | 18.64 | 20.15 | 22.87 | 26.00 | 28.71 | 31.39 | 37.21 | 44.41 |
| 29 | 13.56 | 15.13 | 15.93 | 18.22 | 19.49 | 21.04 | 23.83 | 27.05 | 29.85 | 32.61 | 38.63 | 46.07 |
| 30 | 14.25 | 15.86 | 16.68 | 19.03 | 20.34 | 21.93 | 24.80 | 28.11 | 31.00 | 33.84 | 40.05 | 47.74 |
| 31 | 14.94 | 16.60 | 17.44 | 19.85 | 21.19 | 22.83 | 25.77 | 29.17 | 32.14 | 35.07 | 41.46 | 49.40 |
| 32 | 15.63 | 17.34 | 18.21 | 20.68 | 22.05 | 23.73 | 26.75 | 30.24 | 33.28 | 36.30 | 42.88 | 51.06 |
| 33 | 16.34 | 18.09 | 18.97 | 21.51 | 22.91 | 24.63 | 27.72 | 31.30 | 34.43 | 37.52 | 44.30 | 52.72 |
| 34 | 17.04 | 18.84 | 19.74 | 22.34 | 23.77 | 25.53 | 28.70 | 32.37 | 35.58 | 38.75 | 45.72 | 54.38 |
| 35 | 17.75 | 19.59 | 20.52 | 23.17 | 24.64 | 26.44 | 29.68 | 33.43 | 36.72 | 39.99 | 47.14 | 56.04 |
| 36 | 18.47 | 20.35 | 21.30 | 24.01 | 25.51 | 27.34 | 30.66 | 34.50 | 37.87 | 41.22 | 48.56 | 57.70 |
| 37 | 19.19 | 21.11 | 22.08 | 24.85 | 26.38 | 28.25 | 31.64 | 35.57 | 39.02 | 42.45 | 49.98 | 59.37 |
| 38 | 19.91 | 21.87 | 22.86 | 25.69 | 27.25 | 29.17 | 32.62 | 36.64 | 40.17 | 43.68 | 51.40 | 61.03 |
| 39 | 20.64 | 22.64 | 23.65 | 26.53 | 28.13 | 30.08 | 33.61 | 37.72 | 41.32 | 44.91 | 52.82 | 62.69 |
| 40 | 21.37 | 23.41 | 24.44 | 27.38 | 29.01 | 31.00 | 34.60 | 38.79 | 42.48 | 46.15 | 54.24 | 64.35 |
| 41 | 22.11 | 24.19 | 25.24 | 28.23 | 29.89 | 31.92 | 35.58 | 39.86 | 43.63 | 47.38 | 55.66 | 66.02 |
| 42 | 22.85 | 24.97 | 26.04 | 29.09 | 30.77 | 32.84 | 36.57 | 40.94 | 44.78 | 48.62 | 57.08 | 67.68 |
| 43 | 23.59 | 25.75 | 26.84 | 29.94 | 31.66 | 33.76 | 37.57 | 42.01 | 45.94 | 49.85 | 58.50 | 69.34 |
| 44 | 24.33 | 26.53 | 27.64 | 30.80 | 32.54 | 34.68 | 38.56 | 43.09 | 47.09 | 51.09 | 59.92 | 71.01 |
| 45 | 25.08 | 27.32 | 28.45 | 31.66 | 33.43 | 35.61 | 39.55 | 44.17 | 48.25 | 52.32 | 61.35 | 72.67 |

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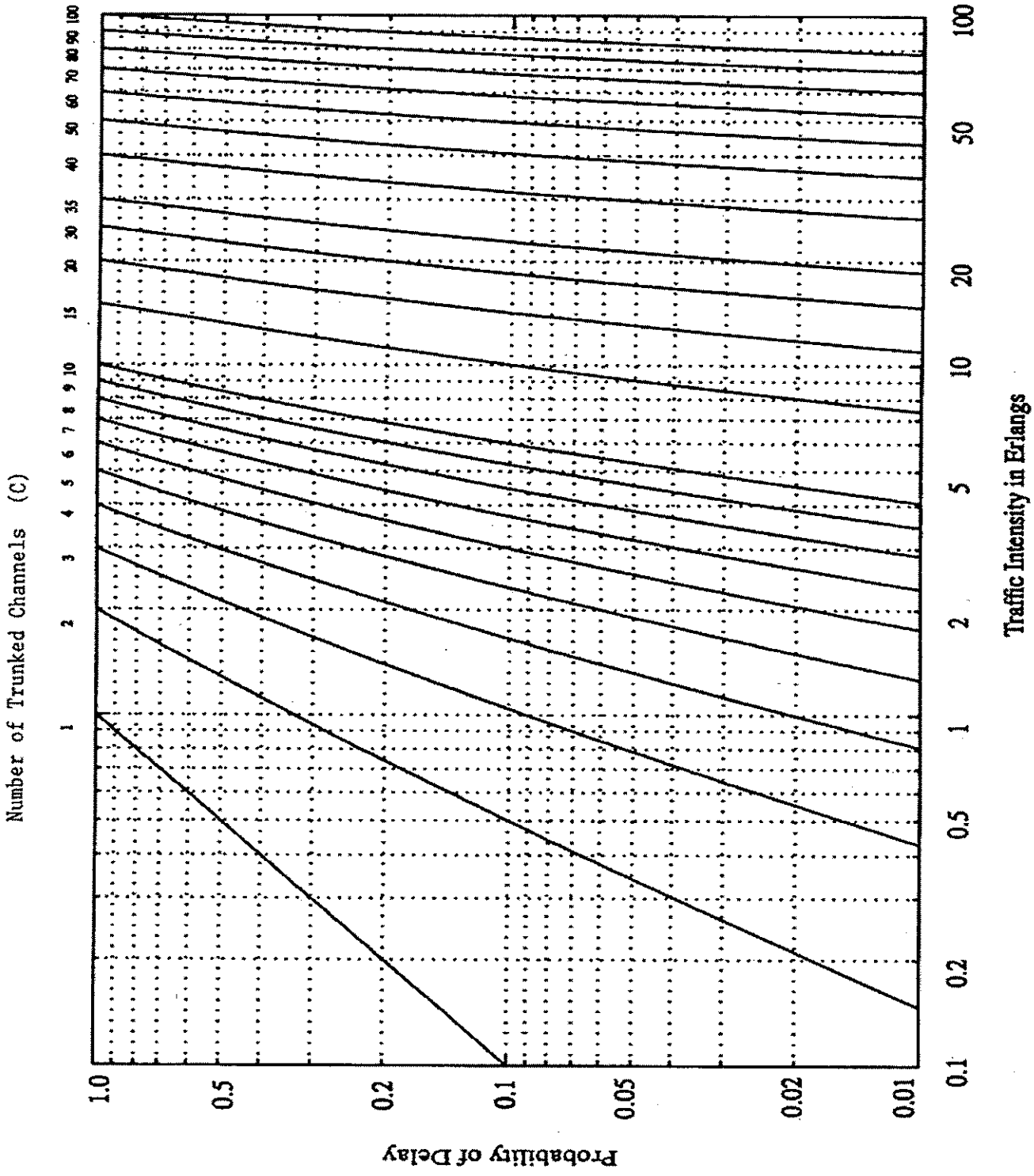


The Erlang C chart showing the probability of a call being delayed as a function of the number of channels and traffic intensity in Erlangs.

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